

The ground activity of spiders (Araneae) and harvestmen (Phalangidae) in West Bengal, India¹

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(With eight text-figures)

Spiders and harvestmen were collected from August 1971 through August 1972 with pit-fall traps set once each week in four different habitats: a tree-shrub site, a bamboo grove, a banana grove, and a grassy plot. During the first eleven months of the study 901 spiders representing 19 species and 11 families were collected, 36 per cent of which occurred on the grassy plot. The family Lycosidae accounted for 93 per cent of the spiders collected and was primarily represented by two species: *Lycosa birmanica* and *L. sumatrana*. The former species was most active on the grassy plot and in the tree-shrub site during the premonsoon-monsoon months, and the latter was most active on the grassy plot during the monsoon-postmonsoon months. Females of these two species, and of *L. tista* and *Drassodes oppenheimeri* were more active than the males. Harvestmen were most active on the ground in the tree-shrub site, particularly in March; a total of forty was caught. The low number of species caught in this study, as compared to temperate zone studies, is probably due in part to trapping procedure and to habitat disturbance brought about by the activities of man and his domesticated animals. New species distribution records are noted.

INTRODUCTION

Spiders and harvestmen, along with carabid beetles, are extremely important predators of the ground dwelling micro-fauna (Williams 1962). Their diet is known to consist of those organisms that are abundant, slow moving or inactive, and soft of body, such as smaller spiders, beetles, homopterans, hymenoptera and flies (Breymeyer 1967; Goodnight 1961). Flies are a very important part of the diet of lycosid

spiders, at least at certain times of the year (Edgar 1969, 1971a). This takes on added significance when the role of flies in the transmission of bacteria, viruses, and parasites pathogenic to man and his domesticated animals, particularly in the tropics, is taken into consideration (Graham-Smith 1913; Pipkin 1949; Roberts 1934).

A large number of studies have been done on the seasonal activity of spiders and harvestmen on the ground in temperate regions, pri-

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marily in Europe (Edgar 1971a; Russell-Smith & Swann 1972; Williams 1962), but such knowledge is lacking for the tropical regions. Probably one of the main reasons for this is that the taxonomy of spiders and harvestmen in temperate regions is relatively well known, whereas in tropical regions it is in many cases still being worked out. The opportunity to gain such information in a tropical area arose during the course of a study of dung beetle ecology by one of us (J.R.O.), which will be reported on later. The data presented in this paper are based on the collection of spiders and harvestmen obtained over a thirteen month period from ground level pit-fall traps.

METHODS

Spiders were trapped weekly from 14 August 1971 to 1 September 1972. During the first six months, up to the end of February 1972, traps were set once each week in each of two villages: Nasibpur and Burasanti. Thereafter, traps were set once a week in only one village: Burasanti. Each village contained four trap-site habitats: a tree-shrub site, a bamboo grove, a banana grove, and a grassy plot. Trapping on the grassy plot was terminated at the end of June 1972, two months prior to the end of the study. Eight pit-fall traps in two parallel rows of four were set at each trap-site. Thus initially each village had a total of thirty-two traps.

The traps were set out between 1500 and 1600 hrs in the afternoon and were picked up the following morning between 0900 and 1000 hrs. This timing of the trap period was related to the activity cycle of scarabid dung beetles and not to the activity of spiders. The traps (23.5 cm in diameter) were sunk in the ground so that the upper rim was flush with the soil surface. A cup filled with sand was placed in

the centre of the trap so that a circular band about 2.5 cm wide served as the entrance to the trap. In some traps fecal material was placed on top of the sand in the cup to serve as bait. All the spiders and phalangids caught were found inside the trap, not in the cup. There was no significant difference in the number of spiders caught in the different baited traps, nor between baited and unbaited traps. After removal from the traps, the specimens were sorted, counted and then preserved in alcohol until they could be identified. Phalangids were identified as such, but spiders were identified to species and sex when possible. All specimens are now part of the collection of the Zoological Survey of India.

The species diversity within and across habitats and seasons, and the habitat niche breadth were calculated using Shannon's information theory measure [$H \approx 3.321928/N (N \log_{10} N - \sum n_i \log_{10} n_i)$] and the table for $n \log n$ values in Lloyd *et al.* (1968).

As will be made clear in the discussion, the number of spiders caught in pit-fall traps is indicative of spider activity on the ground and not of spider abundance. Therefore, in the Results section, the data will be presented in terms of activity on the ground.

STUDY AREA

The two villages were approximately five kilometres apart and were 40 km NNW of Calcutta, in the state of West Bengal, India. The villages were densely settled, with some areas within the villages devoted to household gardens, bamboo groves, banana groves, and grassy areas, which occasionally were used to grow crops or as playgrounds. The areas outside of the village limits were devoted to raising of jute, rice, and some wheat and vegetables.

The four trap-sites in each village were chosen to represent the four more important vegetation types in the villages, as mentioned above. The tree-shrub sites were mango groves, which had a few palm trees, as well as some other tree species, interspersed. The branches and leaves of these trees formed a thick closed canopy throughout the year. A dense shrub layer, about one metre high, covered the ground, except in the area immediately around the traps. The bamboo groves had clumps of bamboo plants scattered within them, but the trunks of the plants arched over the open areas within the groves so that a thin, but almost closed canopy was formed. The ground surface in the open areas was covered with a thin layer

by cattle and goats. Canopy plants and canopy were lacking. During the monsoon months, some inedible weeds grew up to about 30 cm in height and provided an open "shrub-type" layer on the Burasanti grassy plot. These weeds died back fairly quickly at the beginning of the dry season. Diurnal soil surface temperatures were highest in the banana grove and grassy plot, and lowest in the bamboo grove and tree-shrub site.

The pit-fall traps were placed in the centre of the trap-site habitats when possible. The area of the habitats was variable, ranging from 450m² to 4275m², with those in Nasibpur larger than those in Burasanti. Since the areas of the trap-site habitats were variable, and in some

TABLE 1

DEGREE OF HETEROGENEITY OF TRAP-SITE HABITATS—PER CENT OF AREA COVERED WITH DIFFERENT TYPES OF VEGETATION OR DEVOTED TO OTHER TYPES OF LAND USE WITHIN A CIRCLE OF 20 M RADIUS CENTRED AT THE TRAP LOCATION

	Burasanti				Nasibpur			
	Tree-shrub	Bamboo	Banana	Grass	Tree-shrub	Bamboo	Banana	Grass
Shrub	16	16	22	8	25	—	11	27
Tree-shrub	35	—	—	—	33	—	—	—
Bamboo	—	69	—	13	—	88	—	—
Banana	—	—	70	3	30	—	73	8
Grass	—	9	—	43	—	—	—	35
Paths or Cleared	24	—	8	—	7	—	—	—
Houses and Ponds	25	5	—	33	6	12	16	29

of dead bamboo leaves except in the area immediately around the traps, which was bare. The banana groves had banana plants spaced 3 to 4 metres apart. The leaves of the banana plants formed an open canopy, and each day all the soil surface within the groves received direct sunlight. The soil surface was bare. The grassy plots had a layer of grass throughout the year, which was kept short due to grazing

the trap locations were off-centre, a better measure is to quantify the habitat heterogeneity within given distances from the trap locations. All trap-sites were homogenous for habitat type within a circle of 4 m radius (50m²) from the centre of the trap location. All trap-sites were heterogeneous for habitat type within a circle of 20 m radius (1252m²) from the centre of the trap location. The "bamboo"

and "banana" trap-sites, however, still tended to be representative of their respective habitats, whereas the "tree-shrub" and "grass" trap-sites were less so (Table 1).

The study was started at the height of the monsoon in 1971 and was terminated during the height of the monsoon in 1972 (Fig. 1).

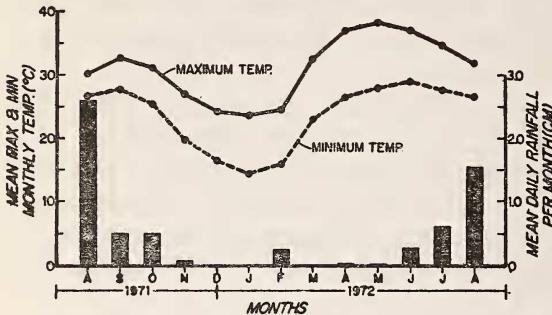


Fig. 1. Mean maximum and minimum daily temperatures per month (°C): ● —● maximum, ○ —○ minimum; and mean daily rainfall per month (cm): histograms; in Burasanti village from August 1971 to August 1972.

More rain fell in 1971 than in 1972, and in August 1971 the traps were filled with water and the trap-sites were flooded half the time. Such conditions did not exist during 1972. The total rainfall for Burasanti and Nasibpur from September 1971 through August 1972 was 120 cm and 107 cm respectively. Temperatures were higher in August 1972 than in August 1971, due to the lower frequency of cloud cover.

THE GROUND ACTIVITY OF SPIDERS

Comparison of two villages

During the first seven months of the study, when collections were made in both villages, 550 spiders were obtained. The Nasibpur sites yielded 60 per cent of the spiders, with a mean number of spiders per trap-night of 11.6. This was significantly more than the sites in Burasanti which had a mean of 8.0 spiders per

trap-night ($df = 6$, $t = 3.13$, $p < .05$). Except for the grassy plot, each of the Nasibpur trap-sites had more spiders than did the similar trap-sites in Burasanti (Table 2).

During this part of the study, 15 species of spiders were collected, 9 in each village (Table 2). Three of these species occurred in both villages (*Lycosa birmanica*, *L. sumatrana*, *L. tista*), and they accounted for about 90 per cent of the spiders collected. Since the sample size was small, it was not possible to test whether the distributions of these three species across habitats were the same in both villages. The remaining twelve species occurred in the traps with very low frequency and were, on the average, represented by fewer than three individuals each (range 1 to 10).

The species diversity over the months of September to February for the two villages was similar: Nasibpur—1.79, and Burasanti—1.72 (Table 3).

Hereafter, the data from the first six months from the two villages will be combined.

Comparison of Habitats

Over 900 specimens of 19 different species were obtained during the first 11 months of the study when all four habitats were trapped (Tables 2, 4 and 5). Based on the number of spiders caught, ground activity of spiders was highest on the grassy plot (37%) and lowest in the banana grove (13%). This difference between habitats in relation to spider activity was due to a difference in the number of individuals per species, as there was no significant difference among the habitats in number of species present. The species diversity for the four habitats did vary between villages, and from one season to another, as well as among the habitats, but when all four seasons are taken together, the species diversity in the Burasanti habitats were similar with a range of 1.7 to 1.9 (Table 3). However, in the tree-

TABLE 2

THE NUMBER OF INDIVIDUALS OF EACH SPECIES AND TOTAL NUMBER CAUGHT IN EACH HABITAT PER MONTH

Month and number of trap days per month (Nasibpur/Burasanti)																		Totals	
1971		1972																	
Habitat	Aug. 2/2	Sept. 4/4	Oct. 5/5	Nov. *4/4	Dec. *5/5	Jan. 4/4	Feb. 4/4	Mar. 0/5	Apr. 0/4	May 0/4	June 0/5*	July 0/5*	Aug. 0/5*	Aug. - Nasib.*	Feb. 71 - Bura.	72 Aug. - June	Aug. (Villages combined)		
ARANEAE																			
CTENIZIDAE																			
<i>Acanthodon</i> sp.	BB	—	—	—	—	—	—	—	—	—	—	—	—	1	0	0	1		
THERAPHOSIDAE																			
<i>Phlogiodes validus</i>	TS	—	—/1	—/2	—	—	—	—	—	—	—	—	—	—	0	3	3		
OONOPIDAE																			
<i>Diblenma</i> sp.	TS	—	—	—	—	—	—	—	—	—	—	—	—	2	0	0	2		
	BB	—	—	—	—	—	—	—	—	—	—	—	—	2	0	0	2		
	BN	—	—	—	—	1/0	—	—	—	—	—	—	—	4	1	0	5		
Total	—	—	—	—	—	1/0	—	—	—	—	—	—	—	8	1	0	9		
GNAPHOSIDAE																			
<i>Drassodes malodes</i>	BB	—	—	—	—	—	—	—	1	—	—	—	—	—	0	0	1		
<i>D. oppenheimeri</i>	TS	—	—	—	—	—	2/0	—	—	—	—	—	—	—	2	0	5		
	BB	—	—	—	1/0	1/0	—	—	—	—	—	—	—	1	2	0	3		
	BN	—	—	1/0	—	—	4/0	1	—	—	—	—	—	1	5	0	6		
	G	—	—	—	—	—	1/0	—	1	—	—	—	—	21	1	0	23		
Total	—	—	1/0	1/0	1/0	1/0	6/0	2	—	—	—	25	1	1	10	0	37		
																	16		

TABLE 2 (continued)

		1971		1972												Totals	
Habitat		Aug. 2/2	Sept. 4/4	Oct. 5/5	Nov. *4/4	Dec. *5/5	Jan. 4/4	Feb. 4/4	Mar. 0/5	Apr. 0/4	May 0/4	June 0/5*	July 0/5*	Aug. 0/5*	Aug. - Bura.*	Aug. - June (Villages combined)	
<i>Gnaphosa</i> sp.	TS	—	—	—	—	—	—	—	1	—	—	—	—	—	0	1 1	
THERIDIIDAE																	
<i>Cylognatha surabjae</i>	BB	—	—	—	2/0	—	—	—	—	—	—	—	—	—	2	0 2	
<i>Theridion</i> sp.	BN	—	—	1/0	—	—	—	—	—	—	—	—	—	—	1	0 1	
THOMISIDAE																	
<i>Thomisus cherapunjeus</i>	BB	—	—	—	—	—	—	—	—	1	—	—	—	—	0	0 1	
	BN	—	—	—	0/1	—	—	—	—	—	—	—	—	—	0	1 1	
	G	—	—	—	—	—	0/2	—	—	—	—	—	×	×	0	2 2	
	Total	—	—	—	0/1	—	0/2	—	—	1	—	—	—	—	0	3 4	
<i>Xysticus minutus</i>	TS	—	—	—	—	—	—	—	—	1	—	—	—	—	0	0 1	
HETEROPODIIDAE																	
<i>Heteropoda</i> sp.	TS	—	—	1/0	—	—	1/0	—	1	—	—	—	—	—	2	0 3	
	BN	—	—	—	—	—	—	0/1	2	—	—	—	—	—	0	1 3	
	Total	—	—	1/0	—	—	1/0	0/1	3	—	—	—	—	—	2	1 6	
CLUBIONIDAE																	
<i>Castianeira</i> sp.	BB	—	0/2	—	—	—	—	—	—	—	—	—	—	—	0	2 2	
LYCOSIDAE																	
Adult <i>Lycosa</i>	G	—	—	0/3	—	—	—	—	—	—	—	—	×	×	0	3 3	
<i>L. annandalei</i>																×	

TABLE 2 (continued)

		1971												1972												Totals									
		Aug.		Sept.		Oct.		Nov.		Dec.		Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Aug. -							
Habitat		2/2		4/4		5/5		*4/4		*5/5		4/4		4/4		0/5		0/4		0/4		0/5*		0/5*		0/5*		Nasib.*		Bura.		June		Aug.	
																														(Villages		combined)			
<i>L. birmanica</i>	TS	—	2/0	—	—	—	—	—	—	0/1	7/8	—	—	—	—	—	—	17	10	21	26	34	9	9	34	9	34	9	66	126					
	BB	—	3/0	—	—	—	—	—	—	2/0	2/0	—	—	—	—	—	—	—	6	16	15	28	7	0	29	7	28	7	0	29	72				
	BN	—	3/0	—	—	—	—	0/2	—	—	—	0/1	1	—	—	—	—	—	—	13	16	27	3	3	20	3	20	3	20	63					
	G	—	28/0	0/4	—	—	—	6/0	—	—	—	—	—	—	—	—	—	—	4	20	×	×	×	4	62	4	62	4	62	×					
	Total	—	36/0	0/4	—	—	—	6/2	2/1	9/8	0/1	1	17	20	70	57	89	53	16	177	261	—	—	—	—	—	—	—	—	—	—	—	261		
<i>L. nigrotibialis</i>	TS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	2			
	TS	1/0	—	7/0	—	—	—	4/0	10/0	11/0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	38			
	BB	0/4	0/2	1/2	—	—	—	1/2	8/0	2/0	—	—	4	—	—	—	—	—	—	—	—	2	3	12	10	26	31	10	26	31	31				
	BN	—	—	1/0	—	—	—	2/0	0/1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	3	1	5	5	1	5	5	5				
	G	7/3	—	12/1	—	—	—	0/8	1/0	6/0	—	—	—	—	—	—	—	—	—	3	×	×	×	12	41	×	×	12	41	×	×				
<i>L. tista</i>	Total	8/7	0/2	21/3	—	—	—	7/10	19/1	19/0	—	4	—	—	4	2	8	74	23	105	74	—	—	—	—	—	—	—	—	—	—	74			
	TS	—	—	—	—	—	—	—	0/3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3				
	G	—	—	—	—	—	—	—	3/2	1/0	0/9	1	—	—	—	×	×	4	11	16	×	×	×	11	16	×	11	16	×	16	×				
	Total	—	—	—	—	—	—	—	3/5	1/0	0/9	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3				
	<i>Lycosa</i> sp.	TS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1			
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BN		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1				
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<i>Lycosa</i> sp.	TS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	BB	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	BN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	G	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
<i>Lycosa</i> sp.	TS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	BB	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	BN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	G	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
<i>Lycosa</i> sp.	TS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	BB	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
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	G	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
<i>Lycosa</i> sp.	TS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	BB	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	BN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	G	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
<i>Lycosa</i> sp.	TS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
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	BN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	G	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
<i>Lycosa</i> sp.	TS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×			
	BB	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—																		

TABLE 2 (continued)

		1972												Totals							
		1971		Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Aug.-				
Habitat		2/2	4/4	5/5	4/4	5/5	*4/4	*5/5	4/4	4/4	0/5	0/4	0/4	0/5*	0/5*	0/5*	Nasib.*	Bura.	June	Aug.	
		(Villages combined)																			
Juvenile <i>Lycosa</i>	TS	3/2	2/0	4/3			11/1	15/18	11/11	15/2	18	12	3	1	—	4	61	37	132	136	
	BB	—	1/0	0/1			3/8	10/13	23/11	24/3	28	17	—	1	—	2	61	36	143	145	
	BN	—	0/1	3/4			8/2	11/3	11/4	4/4	1	8	3	2	—	7	37	18	69	76	
	G	—	3/8	1/4			2/2	5/23	1/12	6/14	28	32	22	15	×	×	18	63	178	×	
	Total	3/2	6/9	8/12			24/13	41/57	46/38	49/23	75	69	28	19	—	13	177	154	522	357	
<hr/>																					
OXYOPIDAE																					
<i>Oxyopes</i> sp.		BB	—	—	—	—	—	—	—	—	1	—	—	—	—	—	0	0	1	1	
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SALTICIDAE																					
<i>Maevia</i> sp.		BB	—	1/0	—	—	—	—	—	—	—	—	—	—	—	—	1	0	1	1	
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Total No. of individuals		TS	4/2	4/1	12/5			15/1	25/22	30/19	17/2	20	32	13	25	26	46	107	52	249	321
		BB	0/4	5/4	1/3			7/10	21/13	27/11	24/3	34	19	6	18	17	37	85	48	210	264
		BN	—	3/1	6/6			10/5	12/4	11/8	8/6	6	8	3	19	17	39	51	30	116	173
		G	7/3	31/8	13/12			8/10	9/25	9/14	6/23	30	32	26	60	×	×	83	95	326	×
		Total	11/9	43/14	32/26			40/26	67/64	77/52	55/34	90	91	48	122	60	122	326	225	901	758
<hr/>																					
Total No. of Spider species per month		TS	1/1	2/1	2/1			1/1	1/2	3/2	2/1	3	3	1	2	1	4	4	3	9	10
		BB	0/1	2/2	1/1			3/1	2/1	2/1	1/1	3	2	1	2	2	5	5	2	10	12
		BN	—	1/1	3/1			1/2	2/1	1/1	2/2	4	1	1	3	2	3	5	5	8	8
		G	1/1	2/1	1/3			1/1	2/1	3/2	1/1	2	1	1	4	×	×	4	5	7	×
		Total	1/1	3/4	4/5			4/3	5/3	5/3	2/3	9	5	1	4	3	6	9	9	19	20

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TS = Tree-shrub; BB = Bamboo; BN = Banana; G = Grass.

*The Nasibpur Grassy Plot was trapped only 2 times in November and 2 times in December. No trapping was done on the Burasanti Grassy Plot in July and August of 1972, and in June it was trapped only 4 times.

shrub, bamboo and grass habitats there was a tendency for the mean number of individuals per species to be higher when the number of species was low, and to be low when the number of species was high (Table 4).

There were three different patterns of distribution of the spider species (Table 4). The three species that were present in all four of the habitats (Table 5) were the ones which were the most active, i.e., the species most frequently caught in the pit-fall traps. Those species which occurred in two or three habitats occurred with moderate frequency in the traps, with 3 to 24 individuals caught per species, and could be considered moderately active on the ground. Those species that occurred in only one habitat occurred with very low frequency in the traps, with only 1 to 3 individuals caught per species. These least active or low frequency species accounted for 63 per cent of the spider species caught, but accounted for only 2.1 per cent of the individuals. The number of moderate and high frequency species was similar, but the high frequency species accounted for 93 per cent of the spiders caught (Table 4).

The species composition of the spider fauna in each of the four habitats differed mainly because of the low frequency species, which occurred in only one habitat each (Table 4). The bamboo, banana and grass habitats shared two of the species that occurred with moderate frequency, and the banana and grass habitats each shared one moderate frequency species with the tree-shrub habitat.

Seasonal changes in Spider activity on the Ground

The number of species present varied during the year. The months with the most species active on the ground were October 1971, eight species, and March 1972, nine species. In August 1971 and May 1972 only one species was present: *Lycosa sumatrana* in August and *L. birmanica* in May. The average number of species present in the study per month was 5.0, and the average per month in each habitat was 2.1.

The number of spiders active on the ground gradually increased during the course of the study, but did exhibit wide fluctuations (Fig.

TABLE 3

SPIDER SPECIES DIVERSITY ON THE GROUND WITHIN AND ACROSS SEASONS, HABITATS AND VILLAGES

Village and Seasons	Habitats				Total
	Tree-shrub	Bamboo	Banana	Grass	
Nasibpur					
Sept.-Nov.	1.42	2.41	1.75	1.25	1.94
Dec.-Feb.	1.54	0.98	0.75	1.64	1.44
Sept.-Feb.	1.50	1.37	1.37	1.82	1.79
Burasanti					
Sept.-Nov.	0.99	1.38	1.61	1.75	2.10
Dec.-Feb.	1.08	0.00	1.61	0.87	1.17
Mar.-May	1.46	1.30	1.44	0.44	1.31
June-Aug.	1.00	1.07	1.29	1.87*	1.49*
Sept.-Feb.	1.26	0.97	1.73	1.60	1.72
Mar.-Aug.	1.48	1.75	1.64	1.45*	1.81*
Sept.-Aug.	1.66	1.78	1.87	1.67*	1.97*

* No data for July and August on the grassy plot.

TABLE 4

STRUCTURE OF SPIDER COMMUNITY IN TERMS OF DISTRIBUTION AND ABUNDANCE OF INDIVIDUALS AND SPECIES
(AUGUST 1971-JUNE 1972)

	Mean No. of Individuals per Species and (No. of Species)				For each habitat	% of Individ.	% of Species
	In relation to						
	No. of Habitats	Species Occurred In					
	One	Two	Three	Four			
Tree-shrub	1.8(4)	3.0(2)	—	78.0(3)	27.5(9)	27.1	47.7
Bamboo	1.4(5)	—	1.0(2)	67.0(3)	21.0(10)	23.1	52.6
Banana	1.0(2)	3.0(1)	5.5(2)	33.3(3)	14.5(8)	12.7	42.1
Grass ¹	3.0(1)	17.5(1)	1.5(2)	104.7(3)	48.2(7) *	37.1*	36.8
Mean No. of individuals per species and (tot. no. of species)	1.6(12)	13.3(2)	8.0(2)	283.0(3)	47.95(19)	100.0	100.0
% of individuals	2.1	2.9	1.8	93.2	100.0	911	—
% of species	63.2	10.5	10.5	15.8	100.0	—	19

* chi square $p < .001$.¹ Number of spiders adjusted due to fewer number of trap days.

GROUND ACTIVITY OF SPIDERS AND HARVESTMEN

TABLE 5

DISTRIBUTION OF ARANEAE AND PHALANGIDAE ACROSS HABITATS AND PER CENT OF POPULATION FOR ELEVEN MONTHS (AUGUST 1971 - JUNE 1972)

Scientific name	Per cent of each habitat				Number of individuals	Per cent of population	
	Tree-shrub site	Bamboo grove	Banana grove	Grassy plot 1		By species	By family
CTENIZIDAE							
<i>Acanthodon</i> sp.	—	(100)	—	—	(1)	See text	
THERAPHOSIDAE							0.3
<i>Phlogiodes validus</i>	100	—	—	—	3	0.3	
OONOPIDAE							0.1
<i>Diblemma</i> sp.	—	—	100	—	1	0.1	
GNAPHOSIDAE							4.3
<i>Drassodes malodes</i>	—	100	—	—	1	0.1	
<i>Drassodes oppenheimeri</i>	14	8	16	62**	37	4.1	
<i>Gnaphosa</i> sp.	100	—	—	—	1	0.1	
THERIDIIDAE							0.3
<i>Cyllognatha</i> sp.	—	100	—	—	2	0.2	
<i>Theridion</i> sp.	—	—	100	—	1	0.1	
THOMISIDAE							0.4
<i>Thomisus cherapunjeus</i>	—	100	—	—	1	0.1	
<i>Thomisus</i> sp. (juveniles)	—	—	33	66	3	0.3	
<i>Xysticus minutus</i>	100	—	—	—	1	0.1	
HETEROPODIDAE							0.7
<i>Heteropoda</i> sp.	50	—	50	—	6	0.7	
CLUBIONIDAE							0.2
<i>Castianeira</i> sp.	—	100	—	—	2	0.2	
LYCOSIDAE							93.3
<i>Lycosa annandalei</i> (adults)	—	—	—	100	3	0.3	
<i>Lycosa birmanica</i> (adults)	36	16	11	37**	183	20.1	
<i>Lycosa nigrotibialis</i> (adults)	100	—	—	—	2	0.2	
<i>Lycosa sumatrana</i> (adults)	31	24	5	40**	107	11.7	
<i>Lycosa tista</i> (adults)	13	—	—	87	8	0.9	
<i>Lycosa</i> sp. (adults)	—	8	83	8	12	1.3	
<i>Lycosa</i> spp. (juveniles)	25	27	13	36**	535	58.7	
OXYOPIDAE							0.1
<i>Oxyopes</i> sp.	—	100	—	—	1	0.1	
SALTICIDAE							0.1
<i>Maevia</i> sp.	—	100	—	—	1	0.1	
Total Araneae	27	23	13	37**	911	99.8	99.8
PHALANGIDAE	53	18	11	18*	38	100.0	100.0

*) $p < .01$ and **) $p < .001$ using chi square that such a distribution would occur by chance.

1) Number of spiders adjusted due to fewer number of trap days.

2). The study can be divided into two parts, August 1971 to February 1972, when the activity was low to medium, and March to August 1972, when the activity was medium to high. The major fluctuations were due to changes in the activity of the lycosid spiders, which accounted for 93.3 per cent (Table 5) of the spiders caught (Fig. 2). The adults of the two species, *L. birmanica*

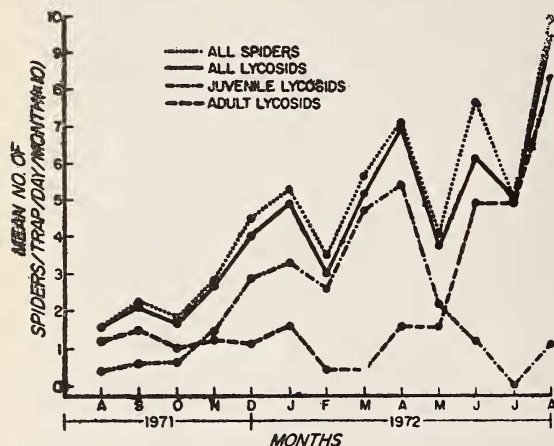


Fig. 2. Monthly changes in spider activity measured in terms of mean number of spiders per trap per day per month ($\times 10$) between August 1971 and August 1972.

and *L. sumatrana*, accounted for 31.8 per cent of the spiders caught. Juvenile lycosids (excluding spiderlings), which can be attributed primarily to these two species, accounted for 58.7 per cent of the spiders. Thus, the adults of these two species, and primarily their young, made up 90.5 per cent of the spiders collected (Table 5). The adult lycosids were least active during February and March 1972, but increased rapidly in activity thereafter (Fig. 2). The juvenile lycosids had two peaks of activity: one in December and January, and the other in March and April. Juveniles of *L. sumatrana* and *L. birmanica* were collected during both periods. Unfortunately, since most juveniles were not identified to species, it could not be

determined whether the activity at one time of the year could be attributed to a single species. This bimodal distribution of juvenile activity occurred in all four habitats (Fig. 3). The drop in juvenile lycosids caught after June (Fig. 2) is due to the fact that no collections were obtained from the grassy plot during July and August. During the previous two months, May and June, more than 75 per cent of the juvenile lycosids were collected from the grassy plot (Fig. 3). The increased in juvenile lycosids during August (Fig. 2) reflects their sudden reappearance on the ground in the tree-shrub, banana and bamboo sites, possibly indicating a shift from the grassy habitat (Fig. 3).

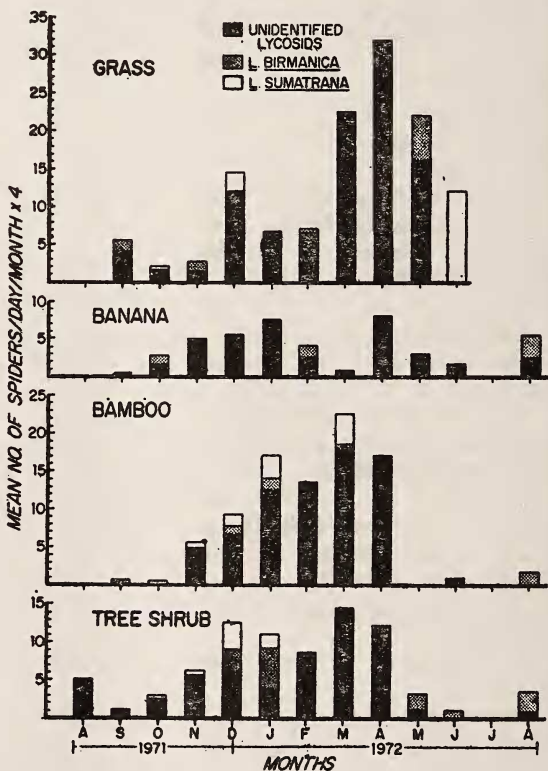


Fig. 3. Mean number of juvenile lycosids caught per day per month ($\times 4$) between August 1971 and August 1972 in all habitats.

THE SPECIES

During the first 11 months of the study 12 species occurred at low frequency (from one to three individuals) in the traps and each was found in only one habitat (Tables 2, 4 and 5): *Castianeira* sp. (1 male, 1 female), *Cylognatha surajbae* Patel & Patel (1 male, 1 female), *Diblemma* sp. (1 juvenile), *Drassodes malodes* Tikader (1 male), *Gnaphosa* sp. (1 male), *Lycosa annandalei* Gravely (3 females), *Lycosa nigrotibialis* Simon (2 females), *Maevia* sp. (1 male), *Oxyopes* sp. (1 male), *Phlogiodes validus* Pocock (1 juvenile, 2 males), *Theridion* sp. (1 juvenile female), and *Xysticus minutus* Tikader (1 female). One additional low frequency species occurred in the last month of the study: *Acanthodon* sp. (1 male). In August 1972 one juvenile and seven adult male *Diblemma* sp. were captured (Table 2), which indicates that this species should actually be considered with those that occurred with a moderate frequency in the traps.

Four species did occur in the traps with moderate frequency (4 to 19) during the first 11 months of the study and were present in two or three of the habitats (Tables 2, 4 and 5): *Heteropoda* sp. (6 juveniles), *Lycosa tista*

Tikader (11 juveniles, 2 males, 6 females), *Lycosa* sp. (12 males, 3 females), and *Thomisus cherapunjeus* Tikader (3 juveniles, 1 male). The most numerous of these four species was *L. tista*, 84 per cent of which were captured in the grass habitat (Fig. 4). This species had a habitat niche breadth of 0.63. Except for *Lycosa* sp., the adults of these species occurred only during the cool dry time of the year (Table 2).

Three species occurred with a high frequency (39 and above) in the traps and were captured in all four habitats (Tables 2, 4 and 5): *Drassodes oppenheimeri* Tikader, *Lycosa birmanica* Thorell, and *L. sumatrana* Thorell. These three species had habitat niche breadths of 1.54, 1.84 and 1.82, respectively. *D. oppenheimeri* accounted for 3.6 per cent of the spiders collected, whereas the adults of the two lycosid species accounted for 31.8 per cent. The

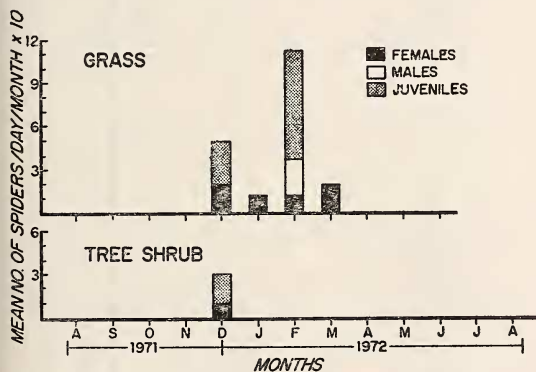


Fig. 4. Mean number of individuals of *Lycosa tista* caught per day per month ($\times 10$) between August 1971 and August 1972 in all habitats.

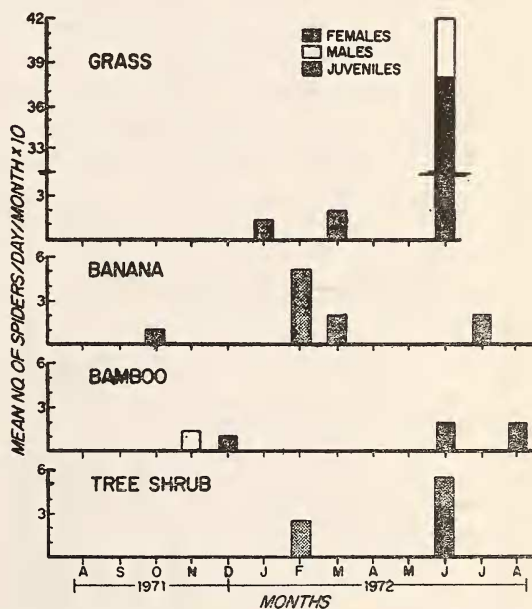


Fig. 5. Mean number of individuals of *Drassodes oppenheimeri* caught per day per month ($\times 10$) between August 1971 and August 1972 in all habitats.

adults of these three species were caught in the traps primarily during the warm wet months (Figs. 5, 6 and 7).

D. oppenheimeri had an adult sex ratio on the ground of 1 male to 8.3 females, based on 28 adults. The males and females occurred most frequently during the hot wet months, particularly in the grass habitat, whereas the juveniles were most abundant during the cool dry months, particularly in the banana grove and did not occur at all in the bamboo grove (Fig. 5). It was unfortunate that no traps were set on the grassy plot during July and August, 1972, as this species had shown a preference for that habitat ($df = 3$, chi square = 27.8, $p < .001$).

If one includes some of the unidentified lycosid juveniles (Tables 2 and 5), *L. birmanica* probably accounted for over 50 per cent of the spiders collected. Only 52 of the 546 juvenile lycosids, however, could be identified or attributed to this species. The overall sex ratio was 1 male to 1.7 females, based on 323 adults; however, the ratio was lower in the tree-shrub (1:1.6, $N = 126$) and bamboo (1: 1.5, $N = 70$) habitats, and higher in the banana

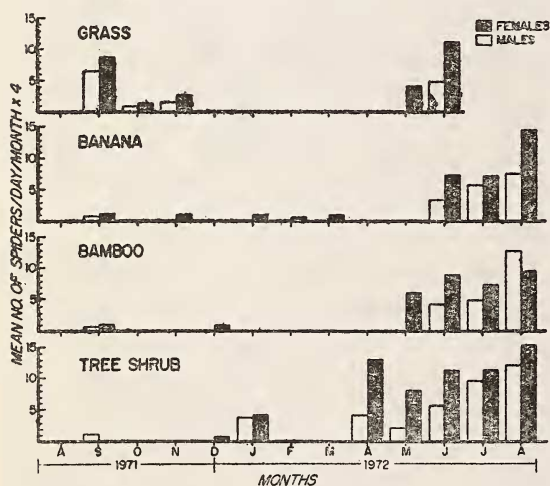


Fig. 6. Mean number of adult *Lycosa birmanica* caught per day per month ($\times 4$) between August 1971 and August 1972 in all habitats.

TABLE 6

NUMBER OF FEMALES CAPTURED WITH EGG SACS AND SPIDERLINGS IN EACH HABITAT DURING STUDY*

	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Total No. of females
<i>L. birmanica</i>														
Egg sacs	—	—	—	—	—	—	—	—	—	1G	—	—	2BN	3
Spiderlings	—	—	—	—	—	—	—	—	1TS	1TS	1BN	—	1BB 1BN	5
<i>L. sumatrana</i>														
Egg sacs	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Spiderlings	—	—	—	1BN	1BN	—	—	—	—	—	1G	—	—	3

* TS = Tree-shrub, BB = Bamboo, BN = Banana, G = Grass

(1:2.1, $N = 65$) and grass (1:1.8, $N = 62$) habitats. This species showed a strong preference for the tree-shrub and grass habitats ($df = 3$, chi square = 40.41, $p < .001$). Except for August 1971, adults of this species were present on the ground throughout the study (Fig. 6). The activity was low on the ground for the first eight months, but starting in April it increased fairly rapidly and reached a much higher level ($df = 3$, chi square = 695.8, $p < .001$). Females with egg sacs or spiderlings were captured between April and August 1972 (Table 6). The largest numbers of spiderlings removed from a trap were 13, 22, and 25. During the months when both villages were trapped, this species was 3.7 times more abundant in Nasibpur (adjusted $N = 75$), but the habitat niche breadths were similar: 1.47 in Nasibpur and 1.42 in Burasanti.

L. sumatrana probably accounted for over 30 per cent of the specimens collected, if one includes some of the unidentified lycosid juveniles (Tables 2 and 5); however, only 52 of the 546 juvenile lycosids could be identified as or directly attributed to this species. When adults were present on the ground, females

tended to be more frequent than males (Fig. 7), with a sex ratio of 1 male to 1.8 females based on 115 adults; however, the ratio was lower in the bamboo habitat (1:1.4, $N = 31$), and higher in the tree-shrub (1:1.9, $N = 38$), grass (1:1.9, $N = 41$) and banana (1:4.0, $N = 5$) habitats. The adults were most active on the grassy plot and least active in the banana grove ($df = 3$, chi square = 29.0, $p < .001$). Adults were collected in all months of the year, except for February, April and May (Table 2). The activity showed strong seasonal fluctuations ($df = 3$, chi square = 30.75, $p < .001$), and tended to be high between August 1971 and January 1972 (Fig. 7). The activity was low from February to May and then increased again gradually from June to August. Three females carrying respectively 15, 18 and 34 spiderlings were captured from the banana and grass habitats (Table 6). During the months when both villages were trapped, this species was 3.3 times more abundant in Nasibpur (adjusted $N = 99$), and the habitat niche breadth was wider in Nasibpur (1.66) than in Burasanti (1.21).

THE GROUND ACTIVITY OF HARVESTMEN

During the initial phase of the study when collections were made at both villages 25 phalangids were caught (Table 2). They occurred almost equally in the two villages, with 52 per cent in Burasanti, but the habitat niche breadth was wider in Burasanti (1.78) than in Nasibpur (1.33).

Thirty-eight phalangids were collected during the first 11 months of the study, and were most active on the ground in the tree-shrub habitat ($df = 3$, chi square = 16.11, $p < .01$). They were next most active in the bamboo grove and on the grassy plot, and were least active in the banana grove (Tables 2 and 5). Phalangids were active on the ground in all months, except August 1971 and July 1972,

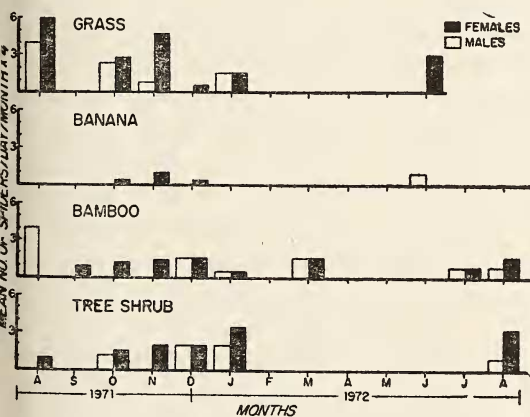


Fig. 7. Mean number of adult *Lycosa sumatrana* caught per day per month ($\times 4$) between August 1971 and August 1972 in all habitats.

and were most active during March in the tree-shrub site (Fig. 8). In Burasanti phalangids

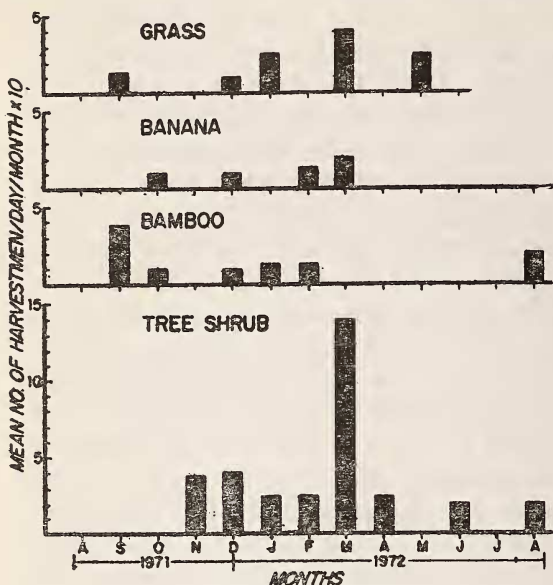


Fig. 8. Mean number of harvestmen caught per day per month ($\times 10$) between August 1971 and August 1972 in all habitats.

had an overall habitat niche breadth of 1.73, which was slightly less than that of spiders, 1.91.

DISCUSSION

Taxonomy and Distribution

As mentioned in the introduction the spider fauna of tropical areas is still being described. In this study the geographic distribution for a number of species have been increased and at least one new species was found. The two specimens of *Castianeira* sp. represent the first report of the subfamily Micariinae for India. Three species, *Cylognatha sarajbae*, *Lycosa nigrotibialis* and *Phlogiodes validus* have previously only been reported from western India (Patel & Patel 1972; Pocock 1900). *Lycosa tista* was collected previously about 370 km

to the north of the present study site, along the Tista River in Sikkim (Tikader 1970), whereas *Drassodes malodes* was previously collected 40 km to the south of the present study site in Calcutta (Tikader 1962). *Drassodes oppenheimeri* is presently only known from the site of this study (Tikader 1973).

Interpretation of Pit-fall trap data

A number of factors, such as seasonal vertical and horizontal migrations, timing of the diel trap period, and trap-site area and heterogeneity may place restrictions on the ecological interpretation of the results.

Pit-fall trap data in particular are subject to a number of limitations. Those species which make extensive movements on the ground are more likely to be caught in the trap than those species which confine their movements to a web or to a small area around an ambush site or to objects above the ground, such as logs or foliage. Some species at certain times of the year may be more active in the vegetation than on the ground and this will be reflected in the trap records as periods of "abundance" and "rarity" (Merrett 1968; Williams 1962). Seasonal shifts from one habitat to another will introduce other discontinuities in the trap record (Edgar 1971a). Other species may be quite abundant on the ground at certain times of the year, but are in an inactive state at other times, usually during the winter or cool months. Therefore pit-fall trap data are indicative only of activity on the ground in the area around the traps in a particular habitat. They are not indicative of the age of maturity or actual abundance (Merrett 1967). This complexity of variables, plus the presence of winter and summer active age groups and species, probably explains the lack of clear cut trends in the species diversity within a habitat from one season to the next (Table 3).

The timing of the diel trap period may have

led to selective capture of spiders and harvestmen. Harvestmen are reported to be mainly nocturnal, with a number of species active crepuscularly and only a few active diurnally (Williams 1962). Thus the trapping period was biased in their favour, though relatively few were caught. Some lycosid spiders are diurnal in activity, and are more active in bright sunlight than in dull sunlight, whereas other lycosids may be active during crepuscular periods (Williams 1962). The trap period would thus appear to be biased against diurnal lycosids. But two of the six lycosid species nonetheless made up 91 per cent of the collection. These two species may have been caught primarily during the first and last 3 to 4 hours of the diel trapping period, if they were diurnal, or they may have been crepuscular in activity.

The trap-sites tended to be uniform for a particular vegetation type over a small area. This might tend to obscure the selectivity of the various species of spiders and harvestmen for habitat type. However, it has been demonstrated that habitat specificity can be detected within a three week period between two species of lycosids with one habitat as small as 6 m² (Duffey 1962), which is much smaller than the 50 m² trap-site habitats used in this study. In one study the average density of spiders in a meadow during the active period of the year was 45.5/m², and that of one species of lycosid 9.05/m² (Breymeyer 1967). Other studies have shown that the density of spider populations may range from 5 to over 840/m² (Duffey 1962). Thus the trap-sites used in this study were probably large enough to demonstrate habitat specificity.

Although the banana groves were fairly uniform for habitat type, spider and phalangid activity was lowest there. The banana groves had the highest diurnal soil surface temperatures

and possibly these were too extreme. These high temperatures occurred due to the lack of vegetation cover over the soil surface, which in itself may have made the habitat less attractive to the spiders.

Seasonal and Diel Activity Cycles

The seasonal and diel activities of spiders and harvestmen, and their presence in different habitats have been shown to be related to their sensitivity to the amount of moisture in the air. Some lycosids, particularly in the genus *Lycosa*, have a waterproof epicuticle which allows them to be active in dry situations, such as open scrub during diurnal periods in the summer, whereas harvestmen lack such an epicuticle and tend to be active in damp situations, such as woodlands during nocturnal periods in the winter (Williams 1962). To a certain extent this hypothetical situation occurs in the present study, at least in relation to habitat specificity. The adult lycosids of the two most active species were most frequently captured during the warm to hot months, particularly on the grassy plots. The harvestmen were most active on the ground in the tree-shrub habitats, and were most active during the cool dry months. Their peak of activity in March, which was dry, but warmer than the preceding months, may have been due to greater abundance of prey.

Overall spider activity was low in August 1971 as compared to August 1972. This was primarily due to the low activity of juvenile lycosids and the absence of *L. birmanica* adults in August 1971. The amount of rainfall in August 1971 was almost twice as much as that in August 1972 and frequently the soil surface was under water, whereas in the following year this was not the case. Also, it is known that during periods of heavy rain spider activity is reduced (Merrett 1968).

There were seasonal differences in the activity between those species that occurred with moderate frequency in the traps and those that occurred with high frequency. Three of the four moderate species tended to be active on the ground primarily during the cool dry months; and one of them, *L. tista*, had previously been reported only from the foothills of the Himalayas (Tikader 1970). Three of 19 commonly occurring species caught in England in a grassy dunes area were classified as winter active (Sudd 1972), and another species, *Hahnina helveola*, was found to mature at the start of and remain active throughout the winter (Merrett 1968). The adults of the three species that occurred with high frequency in the traps were primarily active on the ground during the warm wet months: *D. oppenheimeri* in the late premonsoon, *L. birmanica* in the premonsoon and monsoon months, and *L. sumatrana* in the monsoon and postmonsoon months. It may be that those species that are active in the cool dry months as adults are unable to achieve population levels as high as those that are active in the warm wet months as adults. This could be brought about by the lower availability of prey during the cool months and to competition with phalangids and the larger juveniles of *L. birmanica* and *L. sumatrana* that are active at that time. Beetles and flies were most abundant during this study in the warm wet months (Oppenheimer 1972).

Fecundity and differences in the ground activity of males and females

Usually more adult males than females are caught during all or part of the year. If this high level of adult male activity is limited to one part of the year, it may correspond to the time when males are searching for a mate (Duffey 1962; Merrett 1967). This may be followed by a peak in adult female activity, which

corresponds to movements involved in searching for suitable deposition sites for the eggs (Merrett 1967, 1968) and/or to periods when females carry their egg sacs and expose them to the heat of the sun, usually in open sun-lit areas (Edgar 1971a; Vlijm & Kessler-Geschiere 1967). It may be this sunning activity or the related preference for higher temperatures by adult females (Norgaard 1951) which accounts for the presence of more adult females than males of *D. oppenheimeri*, *L. birmanica*, *L. sumatrana* and *L. tista* on the grassy plot. The low number of adult males captured in comparison to the adult females in these species might be explained by the males tending to spend more of their time up in the vegetation, which would restrict them to the habitats with vertical structuring, i.e., the tree-shrub and bamboo habitats. It has been shown that adult females of *L. nigriceps* descend to the ground during maternal periods and are caught in greater numbers than are the adult males (Merrett 1968). A consistently higher capture rate of adult females in certain species has been reported in other studies (Breymeyer 1967; Merrett 1967).

Only a small number of adult females were caught with egg sacs or spiderlings. This may have occurred because females with egg sacs are less active, and because females carry spiderlings on their backs for only a week or less (Edgar 1971a). Thus these females would have a smaller chance of being caught in the traps than would unencumbered females (Vlijm & Kessler-Geschiere 1967). It could also be that egg sacs and spiderlings may be eaten by parents or other spiders after a certain period of stress in the traps.

In the temperate regions adult female lycosids may produce one, two or sometimes three egg sacs (Vlijm & Kessler-Geschiere 1967) during their one reproductive season. In Poland,

where the activity season is short, *Trochosa ruricola* females produce 163.9 eggs per egg sac, which on the average results in 53.6 spiderlings (Breymeyer 1967). In Scotland *Lycosa lugubris* produces on the average 34.5 spiderlings from the first egg sac and 16.7 from the second for a total of 51.2 (Edgar 1971b). The little data obtained in this study indicate that *L. birmanica* and *L. sumatrana* may have a reproductive season and fecundity that is similar to that of *L. lugubris* in Scotland. The reproductive season of *L. birmanica* may last from April to August, which would be sufficiently long for the production of two, or perhaps three, egg sacs.

Number of Species and comparison with Temperate Zone studies

Duffey (1962) has suggested that habitats with a high vegetation diversity will support a large number of spider species, whereas habitats with greater vegetation uniformity will support spider populations of high density but of fewer species. If the banana grove is omitted from consideration due to its extreme microclimate, the above relationship appears to be supported by this study. The grassy plot had the most uniform vegetation and had more individuals that were active on the ground per species than did the tree-shrub or bamboo habitats.

The number of species of spiders collected during this study (20) and the average number of species caught per habitat (9.5) was low when compared to similar studies in the temperate region. In a study on a 2.8 acre limestone grassland, consisting of three habitats, 141 species of spiders were caught, which is one-fourth of the total spider fauna known for England (Duffey 1962). Eighty of these species were caught in the pit-fall traps and the average number of species per habitat was

59. In other studies 46 species were collected in an open scrub area, 39 species in a woodland (Williams 1962), and 40 species in a chestnut forest with a beech understory (Russell-Smith & Swann 1972). In all of the above mentioned studies the family Linyphaeidae, whose members are known to build webs for the capture of prey, made up 50 to 72 per cent of the species caught. If only non-web building, cursorial species are considered, then the mean number of species caught per habitat was 23 (range 10 to 33), which is more than twice as many as were found in this study. The lycosids in the above studies accounted for 43 per cent of the cursorial species in each habitat (range 30 to 64%), and 55 per cent of the cursorial spiders (range 33 to 74%). In this study they similarly accounted for 45 per cent of the cursorial species (range 25 to 71%) in each habitat, but they made up 94 per cent of the cursorial spiders (range 93 to 96%). The average number of species caught per month in each habitat in England was 20.9 (Duffey 1962), which is ten times higher than in the present study.

Thus the species diversity of the spider fauna in the temperate zone studies was much greater than that found in this study done in a tropical region. This may be explained in part by differences in trapping procedure. In the temperate zone studies mentioned above the traps usually contained a preservative and thus were emptied at weekly or biweekly intervals. Thus the spiders were trapped continually throughout the day and year. This would give the rare or less active species a greater chance to be represented in the collection. Another possible reason for the low number of species in this study is that the habitats used here were highly disturbed. They were located for the most part within villages with large human and domestic animal populations. The grassy plots were more like lawns than meadows,

due to the constant grazing of cattle and goats. The banana groves were devoid of vegetation, except for the banana plants themselves, and the bamboo and tree-shrub sites were used for numerous activities by the villagers. One possible reason why the Nasibpur trap-sites had greater spider activity, and to some extent species diversity, than those in Burasanti may have been because the human population was less dense there and, therefore, there was less disturbance. Also Nasibpur received less rainfall, which might have allowed a higher level of spider activity. Insecticides are being used in the villages, but so far only to a minor extent.

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